

5

INS. A2 Field of the Invention

10

15

20

25

30

35

40

45

50

55

60

65

70

75

80

85

90

95

100

105

110

115

120

125

130

135

140

145

150

155

160

165

170

175

180

185

190

195

200

205

210

215

220

225

230

235

240

245

250

255

260

265

270

275

280

285

290

295

300

305

310

315

320

325

330

335

340

345

350

355

360

365

370

375

380

385

390

395

400

405

410

415

420

425

430

435

440

445

450

455

460

465

470

475

480

485

490

495

500

505

510

515

520

525

530

535

540

545

550

555

560

565

570

575

580

585

590

595

600

605

610

615

620

625

630

635

640

645

650

655

660

665

670

675

680

685

690

695

700

705

710

715

720

725

730

735

740

745

750

755

760

765

770

775

780

785

790

795

800

805

810

815

820

825

830

835

840

845

850

855

860

865

870

875

880

885

890

895

900

905

910

915

920

925

930

935

940

945

950

955

960

965

970

975

980

985

990

995

1000

1005

1010

1015

1020

1025

1030

1035

1040

1045

1050

1055

1060

1065

1070

1075

1080

1085

1090

1095

1100

1105

1110

1115

1120

1125

1130

1135

1140

1145

1150

1155

1160

1165

1170

1175

1180

1185

1190

1195

1200

1205

1210

1215

1220

1225

1230

1235

1240

1245

1250

1255

1260

1265

1270

1275

1280

1285

1290

1295

1300

1305

1310

1315

1320

1325

1330

1335

1340

1345

1350

1355

1360

1365

1370

1375

1380

1385

1390

1395

1400

1405

1410

1415

1420

1425

1430

1435

1440

1445

1450

1455

1460

1465

1470

1475

1480

1485

1490

1495

1500

1505

1510

1515

1520

1525

1530

1535

1540

1545

1550

1555

1560

1565

1570

1575

1580

1585

1590

1595

1600

1605

1610

1615

1620

1625

1630

1635

1640

1645

1650

1655

1660

1665

1670

1675

1680

1685

1690

1695

1700

1705

1710

1715

1720

1725

1730

1735

1740

1745

1750

1755

1760

1765

1770

1775

1780

1785

1790

1795

1800

1805

1810

1815

1820

1825

1830

1835

1840

1845

1850

1855

1860

1865

1870

1875

1880

1885

1890

1895

1900

1905

1910

1915

1920

1925

1930

1935

1940

1945

1950

1955

1960

1965

1970

1975

1980

1985

1990

1995

2000

2005

2010

2015

2020

2025

2030

2035

2040

2045

2050

2055

2060

2065

2070

2075

2080

2085

2090

2095

2100

2105

2110

2115

2120

2125

2130

2135

2140

2145

2150

2155

2160

2165

2170

2175

2180

2185

2190

2195

2200

2205

2210

2215

2220

2225

2230

2235

2240

2245

2250

2255

2260

2265

2270

2275

2280

2285

2290

2295

2300

2305

2310

2315

2320

2325

2330

2335

2340

2345

2350

2355

2360

2365

2370

2375

2380

2385

2390

2395

2400

2405

2410

2415

2420

2425

2430

2435

2440

2445

2450

2455

2460

2465

2470

2475

2480

2485

2490

2495

2500

2505

2510

2515

2520

2525

2530

2535

2540

2545

2550

2555

2560

2565

2570

2575

2580

2585

2590

2595

2600

2605

2610

2615

2620

2625

2630

2635

2640

2645

2650

2655

2660

2665

2670

2675

2680

2685

2690

2695

2700

2705

2710

2715

2720

2725

2730

2735

2740

2745

2750

2755

2760

2765

2770

2775

2780

2785

2790

2795

2800

2805

2810

2815

2820

2825

2830

2835

2840

2845

2850

2855

2860

2865

2870

2875

2880

2885

2890

2895

2900

2905

2910

2915

2920

2925

2930

2935

2940

2945

2950

2955

2960

2965

2970

2975

2980

2985

2990

2995

3000

3005

3010

3015

3020

3025

3030

3035

3040

3045

3050

3055

3060

3065

3070

3075

3080

3085

3090

3095

3100

3105

3110

3115

3120

3125

3130

3135

3140

3145

3150

3155

3160

3165

3170

3175

3180

3185

3190

3195

3200

3205

3210

3215

3220

3225

3230

3235

3240

3245

3250

3255

3260

3265

3270

3275

3280

3285

3290

3295

3300

3305

3310

3315

3320

3325

3330

3335

3340

3345

3350

3355

3360

3365

3370

3375

3380

3385

3390

3395

3400

3405

3410

3415

3420

3425

3430

3435

3440

3445

3450

3455

3460

3465

3470

3475

3480

3485

3490

3495

3500

3505

3510

3515

3520

3525

3530

3535

3540

3545

3550

3555

3560

3565

3570

3575

3580

3585

3590

3595

3600

3605

3610

3615

3620

3625

3630

3635

3640

3645

3650

3655

3660

3665

3670

3675

3680

3685

3690

3695

3700

3705

3710

3715

3720

3725

3730

3735

3740

3745

3750

3755

3760

3765

3770

3775

3780

3785

3790

3795

3800

3805

3810

3815

3820

3825

3830

3835

3840

3845

3850

3855

3860

3865

3870

3875

3880

3885

3890

3895

3900

3905

3910

3915

3920

3925

3930

3935

3940

3945

3950

3955

3960

3965

3970

3975

3980

3985

3990

3995

4000

4005

4010

4015

4020

4025

4030

4035

4040

4045

4050

4055

4060

4065

4070

4075

4080

4085

4090

4095

4100

4105

4110

4115

4120

4125

4130

4135

4140

4145

4150

4155

4160

4165

4170

4175

4180

4185

4190

4195

4200

4205

4210

4215

4220

4225

4230

4235

4240

4245

4250

4255

4260

4265

4270

4275

4280

4285

4290

4295

4300

4305

4310

4315

4320

4325

4330

4335

4340

4345

4350

4355

4360

4365

4370

4375

4380

4385

4390

4395

4400

4405

4410

4415

4420

4425

4430

4435

4440

4445

4450

4455

4460

4465

4470

4475

4480

4485

4490

4495

4500

4505

4510

4515

4520

4525

4530

4535

4540

4545

4550

4555

4560

4565

4570

4575

4580

4585

4590

4595

4600

4605

4610

4615

4620

4625

4630

4635

4640

4645

4650

4655

4660

4665

4670

4675

4680

4685

4690

4695

4700

4705

4710

4715

4720

4725

4730

4735

4740

4745

4750

4755

4760

4765

4770

4775

4780

4785

4790

4795

4800

4805

4810

4815

4820

4825

4830

4835

4840

4845

4850

4855

4860

4865

4870

4875

4880

4885

4890

4895

4900

4905

4910

4915

4920

4925

4930

4935

4940

4945

4950

4955

4960

4965

4970

4975

4980

4985

4990

4995

5000

5005

5010

5015

5020

5025

5030

5035

5040

5045

5050

5055

5060

5065

5070

5075

5080

5085

5090

5095

5100

5105

5110

5115

5120

5125

5130

5135

5140

5145

5150

5155

5160

5165

5170

5175

5180

5185

5190

5195

5200

5205

5210

5215

5220

5225

5230

5235

5240

5245

5250

5255

5260

5265

5270

5275

5280

5285

5290

5295

5300

5305

5310

5315

5320

5325

5330

5335

5340

5345

5350

5355

5360

5365

5370

5375

5380

5385

5390

5395

5400

5405

5410

5415

5420

5425

5430

5435

5440

5445

5450

5455

5460

5465

5470

5475

5480

5485

5490

5495

5500

5505

5510

5515

5520

5525

5530

5535

5540

5545

5550

5555

5560

5565

5570

5575

5580

5585

5590

5595

5600

5605

5610

5615

5620

5625

5630

5635

5640

5645

5650

5655

5660

5665

5670

5675

5680

5685

5690

5695

5700

5705

5710

5715

5720

5725

5730

5735

5740

5745

5750

5755

5760

5765

5770

5775

5780

5785

5790

5795

5800

5805

5810

5815

5820

5825

5830

5835

5840

5845

5850

5855

5860

5865

5870

5875

5880

5885

5890

5895

5900

5905

5910

5915

5920

5925

5930

5935

5940

5945

5950

5955

5960

5965

5970

5975

5980

5985

5990

5995

6000

6005

6010

6015

6020

6025

6030

6035

6040

6045

6050

6055

6060

6065

6070

6075

6080

6085

6090

6095

6100

6105

6110

6115

6120

6125

6130

6135

6140

6145

6150

6155

6160

6165

6170

6175

6180

6185

6190

6195

6200

6205

6210

6215

6220

6225

6230

6235

6240

6245

6250

6255

6260

6265

6270

6275

6280

6285

6290

6295

6300

6305

6310

6315

6320

6325

6330

6335

6340

6345

6350

6355

6360

6365

6370

6375

6380

6385

6390

6395

6400

6405

6410

6415

6420

6425</p

types of consumer electronics. The particular technology selected will generally depend on factors such as the type of applications and system architecture involved.

One area in which inter-application communication is 5 particularly important is in digital television (DTV) systems. The trend in such systems is to separate the DTV functions into two categories: (1) the standardized functions, such as MPEG-2 transport stream demultiplexing and decoding; and (2) proprietary and security-related functions, such as conditional access systems 10 and proprietary applications. The standard functions can then be implemented on a DTV receiver host, and the proprietary and security-related functions can be implemented on a removable card that is inserted into and communicates with the host. The host and removable card interact to provide desired programs and/or services 15 to consumers.

This type of card-host system architecture increases the reusability and extensibility of the DTV receiver. For example, a consumer is able to purchase a DTV receiver in the form of a set-top box that includes a set of standard features. If the consumer 20 then wants to receive premium programs and/or services from a cable operator, the consumer can purchase or lease a removable card from the cable operator or other source. The removable card in this case contains all of the functions needed to allow the consumer to receive and decrypt the premium programs and/or services provided

by the cable operator. In the event that the cable operator adopts new technologies or provides new programs and/or services, the operator can upgrade the removable card, e.g., through a software download or replacement. Alternatively, if the consumer chooses to 5 subscribe to a different cable operator, the consumer can return the removable card to the original operator, and purchase or lease a removable card from the new operator. In any case, the investment of the consumer in the DTV receiver is protected without compromising the ability of the consumer to take advantage of new 10 technologies, programs and/or services.

Another advantage of the above-described card-host system architecture is that it protects the intellectual property rights of content and service providers against hackers who may try to break the system and "steal" the premium programs and/or services. 15 This is due to the fact that all of the proprietary and security-related functions are in a separate removable card that can be disabled and/or replaced if a hacking attempt is detected.

In order for the card-host system architecture to work properly, the host and the removable card must establish a 20 communication channel and protocol. In conventional systems, the host and card typically communicate through message passing, based on a defined set of data descriptors and/or structures. For example, if a consumer wants to order a video on demand (VOD) service, he or she sends a request through a user interface to the

host, and the host in response sends a "VOD requested" data descriptor to the removable card. In such an arrangement, the removable card may then respond by sending a data descriptor that contains the requested list of VODs with the information necessary 5 for ordering.

There are a number of significant drawbacks to the conventional card-host communication described above. First, the data descriptors generally must be standardized, such that the hosts and removable cards, which are usually manufactured by 10 different vendors, can understand each other. However, it is often very difficult to specify standardized "generic" data descriptors that will satisfy all of the vendors, users and other involved parties. Even if such a descriptor is found that appears acceptable and complete at the time it is defined, as new business 15 needs emerge, it may become necessary to add or to remove some items in an existing data descriptor or add a new data descriptor. In such situations, the parties involved are forced to either change an existing standard or do without the desired change. Another significant drawback is that the published details 20 regarding data descriptors may reveal information regarding the inner structure of the removable card, or other information that could be used by hackers to break the system.

Other techniques have been developed for implementing card-host communications. For example, U.S. Patent No. 5,588,146

describes a system in which a removable card stores software programs with rights of access. The software can be downloaded into a microcomputer after the card is inserted therein. U.S. Patent No. 5,739,510 describes the interaction between a removable 5 card and a "dumb" terminal that handles user interface operations including input and output. The card performs application-specific operations, and the results are then communicated with the terminal. Another known technique, described in U.S. Patent No. 5,844,218, relates to a removable card that stores customized 10 information for television receivers, such that different consumers can receive different services bases on the information stored on their cards.

Unfortunately, these and other known techniques have failed to provide an acceptable solution to the above-described problem of 15 inter-application communication in a card-host architecture. A need therefore exists for improved techniques for implementing communications between a removable card and a host device in a DTV system or other system based on a card-host system architecture.

20

INS. A4 Summary of the Invention

The invention provides improved communication between a removable card and a receiver or other host device in a system which is based on a card-host architecture.

In accordance with the invention, a removable card is adaptable for insertion into a corresponding receptacle of a host device, and includes a processor for running at least one application. An agent program is downloadable from the removable 5 card to the host device, such that the agent program runs on a processor of the host device and controls communication between the application running on the processor of the removable card and at least one application running on the processor of the host device. A different agent program may be downloaded from the card to the 10 host device for each of the applications running on the removable card processor, and each such agent program controls communications between its corresponding removable card application and one or more application programming interfaces (APIs) of applications running on the host device processor. As another example, a single 15 agent program can be shared by more than one application running on the removable card. The host device may be, e.g., a digital television (DTV) receiver, and the application running on the processor of the removable card may be a processing operation, e.g., a decryption operation, for a transport stream received via 20 a cable signal.

In accordance with another aspect of the invention, after insertion of the removable card into the receptacle of the host device, a command channel and a data channel are created between the removable card and the host device. The processor of the host

device runs an agent manager program which receives a message from the application running on the processor of the removable card. The message identifies a particular agent program to be downloaded, and in response to the message the agent manager program downloads the 5 agent program from a memory of the removable card via the data channel. The agent program, after being downloaded to the host device, sends a message to the application running on the processor of the removable card via the command channel. The message indicates that the agent program is ready to control communication 10 between the application running on the processor of the removable card and the application running on the processor of the host device. A given application, prior to requesting a download of a particular agent program to the host device, may first query the agent manager program to determine if the particular agent program 15 has already been downloaded by another application. If the particular agent program has already been downloaded, no further downloading is needed and the given application can share the agent program with the other application.

Advantageously, the invention allows a removable card and a 20 host device to communicate without the problems associated with the above-described conventional card-host communication techniques. For example, the invention eliminates the need to standardize data descriptors and/or structures between the cards and the host. In addition, the details of the communication protocol carried out

between the agents and the removable card may be private, i.e., known only to the card and its agents, such that significantly improved resistance to hackers is provided. Although particularly well suited for use in a DTV receiver, the invention can be applied 5 to any system or device in which a removable card communicates with a host. These and other features and advantages of the present invention will become more apparent from the accompanying drawings and the following detailed description.

INS 10 A5 Brief Description of the Drawings

FIG. 1 is a block diagram illustrating communication between a removable card and a host in accordance with the invention.

FIG. 2 shows a more detailed block diagram of an exemplary digital television (DTV) card-host system configured in accordance 15 with the invention.

FIG. 3 is a flow diagram illustrating the operation of the exemplary DTV card-host system of FIG. 2.

INS. A6 Detailed Description of the Invention

FIG. 1 is a block diagram of an illustrative embodiment of a card-host system 10 in accordance with the invention. The system 10 includes a removable card 12 and a host 14. Applications 16-1 and 16-2, also denoted App1 and App2, respectively, are running on the removable card 12. In accordance with the invention, each of the

applications 16-1 and 16-2 that need to communicate with the host 14 has a corresponding agent 18-1 and 18-2, respectively, that is deployed from the removable card 12 into the host 14. The agents 18-1 and 18-2 are also referred to herein as "smart" agents or 5 removable agents. The card 12 and the host 14, although not requiring any specific physical configuration, each generally include a processor and a memory, and may include other types and arrangements of conventional processing elements. The term "card" as used herein is intended to include, e.g., memory cards, Personal 10 Computer Memory Card International Association (PCMCIA) cards, or any other type of device adaptable for removable insertion into a corresponding receptacle of a host.

The agents 18-1 and 18-2 communicate with their corresponding applications 16-1 and 16-2 on the removable card, and also communicate with applications in the host 14. More particularly, agent 18-1 communicates with host application 20-1, also denoted H_App1, and agent 18-2 communicates with host applications 20-2 and 20-3, also denoted H_App2 and H_App3, respectively. Inter-application communication between the card applications and the 20 host applications in the system 10 thus takes place through the agents 18-1 and 18-2.

In operation, when the removable card 12 is inserted into a corresponding slot or other suitable receptacle in the host 14, the communications between the card and host are initialized and

established. The removable card 12 then downloads the agents 18-1 and 18-2 to the host 14 and verifies that the downloading is successful. The downloaded agents 18-1 and 18-2 then set up communication links between themselves and the respective applications 16-1 and 16-2 that they represent on the removable card 12. The applications 20-1, 20-2 and 20-3 on the host 14 and the applications 16-1 and 16-2 on the card 12 then begin to communicate through the agents 18-1 and 18-2.

The agents 18-1 and 18-2 are thus deployed into the host 14 from the card 12 after the card is inserted into the host, and may be viewed as proxies of their corresponding applications 16-1 and 16-2, respectively. The agents can use standardized application programming interfaces (APIs) of host components to communicate with the host applications 20-1, 20-2 and 20-3. The agents can be replaced, updated or removed by the removable card 12 as required to enhance existing applications or to implement new applications.

Advantageously, the system 10 of FIG. 1 eliminates the need to standardize data descriptors and/or structures between the cards and the host. In addition, the details of the communication protocol carried out between the agents and the removable card may be private, i.e., known only to the card and its agents, such that significantly improved resistance to hackers is provided. For example, the communications between the removable card and its agents on the host can be protected by encryption, with the

encryption keys replaced as necessary. It is therefore apparent that use of downloadable smart agents to control card-host inter-application communication eliminates the above-described drawbacks associated with conventional card-host communication.

5 The system 10 of FIG. 1 may be viewed as implementing a client-server model between the host and the removable card, with the applications 20-1, 20-2 and 20-3 on the host 14 representing servers, and the agents 18-1 and 18-2 downloaded to the host from the removable card 12 representing the clients. The agents call 10 the APIs of the servers to invoke services, such as displaying a certain message on a DTV monitor, retrieving remote control messages, etc. It is expected that these APIs in the DTV system context will be standardized, as indicated by the current practice of DTV-related standards bodies such as ATSC DASE, DAVIC, and Sun 15 JavaTV. Once an API standard is finalized for DTV or other card-host system, any agent that is compliant with that standard will be able to interact with the applications of the host 14, and yet as previously noted there will be no need for the host vendors and the card vendors to agree on any particular standardized data 20 descriptors and/or structures.

The downloading of the agents 18-1 and 18-2 from the card to the host may be implemented using a host-specific downloading mechanism. Alternatively, it may be desirable to utilize a

standard card-host downloading mechanism, although it is believed that no such standard is currently available.

It should be noted that the particular number and arrangement of card applications, host applications and removable agents in the FIG. 1 system is by way of example only. The techniques of the invention may be implemented with other numbers and arrangements of applications and agents. For example, although the FIG. 1 system shows a separate agent associated with each of the applications 16-1 and 16-2 running on the removable card 12, in other embodiments one agent may be shared by more than one application running on the removable card.

FIG. 2 shows a more detailed viewed of the card-host architecture of the present invention as implemented in a cable-ready DTV receiver 50. The receiver 50 may represent a set-top box, television, computer or other device, as well as portions or combinations of such devices. The receiver 50 in this implementation includes a removable card 52, a host 54 and a front end 56. The removable card 52 in this embodiment is more particularly referred to as a point of deployment (POD) 52, in accordance with the usual U.S. cable industry terminology for a removable card inserted into a set-top box, as described in OpenCable Set-top Terminal Functional Requirements, FR-OCS-WD01-990422.

The POD 52 includes a central processing unit (CPU) 60, a conditional access system (CAS) module 64, a copyright protection system (CPS) module 66, and an out-of-band (OOB) media access control (MAC)/Datalink module 62. The POD 52 is responsible for 5 the following operations: (1) descrambling scrambled elementary streams in the incoming transport streams as received from the front end 56 via connection 4; (2) copy-protecting the descrambled streams before delivering them to the host via connection 5 and the front end 56; (3) processing downstream OOB signals as received 10 from front end 56 via connection 3, in the OOB MAC/Datalink module 62; and (4) supporting applications.

The POD 52 in this embodiment of the invention may be viewed as a computer or other processing device with dedicated hardware. In this embodiment, it is assumed that the CPU 60 of POD 52 15 includes a memory that stores running application programs and buffers data. The CPU 70 of host 54 is also assumed to include such a memory. Communication between the CPU 60 in the POD 52 and the CPU 70 in the host 54 is through the control and data connections 6 and 7, respectively. Although not shown in FIG. 2, separate 20 memory devices may be included in the POD 52 and host 54, external to their respective CPUs 60 and 70. Such memories may be used to store running applications, to buffer data, and to perform other functions.

In addition to the CPU 70, the host 54 further includes a transport stream demultiplexer 72, a decoder 74, and a graphics module 76. The host 54 is responsible for transport stream demultiplexing, video/audio/data decoding, graphics processing, and 5 on-screen display. The functions and capabilities of the host 54 in this embodiment are thus shared by both terrestrial and cable signal processing operations.

The front end 56 includes both a terrestrial signal receiver and a cable signal receiver. The terrestrial signal receiver 10 includes a 6MHz tuner 80-1, a National Television System Committee (NTSC) demodulator 84, and a vestigial sideband (VSB) demodulator 85. The output of the NTSC demodulator 84 passes directly to the graphics module 76 of the host 54. The cable signal receiver includes a 6 MHz tuner 80-2, a Quadrature Phase-Shift Keyed (QPSK) tuner 82, a Quadrature Amplitude Modulation (QAM) demodulator 86, and a QPSK demodulator 87. The cable signal receiver receives and demodulates in-band QAM-modulated signals, and receives and demodulates out-of-band QPSK-modulated signals.

The outputs of the VSB demodulator 85, QAM demodulator 86 and 20 QPSK demodulator 87 are supplied to a router 90 and can be delivered either to the POD 52 or the host 54. For example, the output of QAM demodulator 86 can go to the demultiplexer 72 on the host 54 via connection 1 or to the POD 52 via connection 4 depending on whether the POD 52 is inserted in its corresponding

slot or other receptacle in the receiver 50. More particularly, if the POD 52 is not inserted, the output of the QAM demodulator 86 goes to the demultiplexer 72 on the host 54, and if the POD 52 is inserted, the output of the QAM demodulator 86 goes to the POD 52 5 through connection 4.

The output of QPSK demodulator 87 comprises in-phase (I) and quadrature (Q) bit streams. If the POD 52 is inserted, these bit streams are supplied to the POD 52 via connection 3 to be further processed for the purpose of execution of MAC/Datalink protocols.

10 Although not shown in FIG. 2, a forward error correction (FEC) module may also be included in the POD 52 for processing the I and Q bitstreams from the QPSK demodulator 87. If the POD 52 is not inserted, the output of the QPSK demodulator 87 is ignored, or optionally goes to OOB MAC/Datalink module 92 in the front end 56. 15 The output of the OOB MAC/Datalink module 92 is applied to the CPU 70 of host 54 via connection 2. The front end may also include the above-noted FEC module.

The router module 90 in the front end 56 routes the outputs of the QAM demodulator 86 and QPSK demodulator 87 to the proper 20 destinations, depending on the insertion status of the POD 52. If the transport stream goes to the POD 52, it will come back from the POD 52, after being processed there, to be forwarded to the demultiplexer 72 on the host 54.

The applications in the POD 52 and host 54 communicate with each other through connections 6 and 7. Connection 6 is referred to herein as a command channel, and is used for transmitting control and configuration commands between the applications in the 5 POD and host. Connection 7 is referred to herein as a data channel, and is used for sending data, such as a file or downloaded code.

FIG. 3 is a flow diagram illustrating in greater detail the interaction process between the POD 52 and the host 54 in setting 10 up a smart agent in receiver 50 of FIG. 2. In step 100, the POD 52 is inserted into its corresponding slot or other receptacle in the host. After that, both the POD 52 and the host 54 go through an initialization phase to properly set up the host/POD interface. In step 102, the host 54 creates transport connections over the above- 15 described command and data channels. The transport connections are used for sending transport packets over the channels. All control and command messages and data are sent in the transport packets.

In step 104, the host 54 starts a smart agent manager program. The smart agent manager program is responsible for downloading a 20 smart agent at the request of an application in the POD 52. In step 106, an application running on the POD 52 sends a message over the command channel to the smart agent manager, requesting the smart agent manager to download a smart agent. The smart agent is then placed in a buffer in a memory of the POD 52. In step 108,

the smart agent manager "pulls" the smart agent from its buffer in the POD 52 through the data channel, places it in a host memory and starts it. In step 110, the smart agent sends a message to its application in the POD 52, indicating that it is ready to operate.

5 In step 112, the application in the POD 52 and the smart agent communicate with each other through the data channel and command channel.

The smart agent then interacts with one or more standardized application programming interfaces (APIs) for accessing services in the host. The smart agent uses these APIs to communicate with the applications on the host. Examples of such APIs include those defined for digital television services by the Data Application Software Environment (DASE) group of the Advanced Television System Committee (ATSC). The DASE APIs are described in greater detail at, e.g., <http://toocan.philabs.research.philips/com/misc/atsc/dase>. It is expected that the DASE APIs will become standardized. A competing standard known as TVPAK, or Microsoft TV, also provides standardized APIs for accessing services in a DTV receiver. The TVPAK standardized APIs are described in greater detail at, e.g., http://www.microsoft.com/tv/news/ne_tvpak_01.asp. Of course, the techniques of the present invention can be applied to many other types of APIs, and can also utilize other types of communication protocols for interacting with the applications running on the host

20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
54.

As mentioned previously, the invention can be implemented such that one agent may be shared by more than one application running on the removable card. In such an embodiment, a given application running on the removable card, before requesting an agent download, 5 queries the above-described agent manager program to see if the particular agent program it wants to use has already been downloaded to the host, e.g., by another application sharing the particular agent program. If the agent program is already in the host, no downloading is needed and the communication between the 10 given application and the particular agent program can start. Otherwise, the agent program is downloaded in the manner described above.

As will be apparent to those skilled in the art, the smart agent and smart agent manager programs described herein can be generated in a straightforward manner, e.g., using conventional 15 programming techniques. For example, the processing operations described in conjunction with the flow diagram of FIG. 3 may be programmed in a straightforward manner using, e.g., the well-known C programming language or other suitable programming language.

20 The embodiments of the invention described herein are intended for purposes of illustration only, and should not be construed as limiting the invention to any particular embodiment or group of embodiments. For example, although illustrated in FIG. 2 in conjunction with a DTV receiver, the invention can be used in many

other card-host systems, including systems in applications such as satellite, cable or broadcast telephony or data delivery, computer communications networks such as the Internet, etc. Moreover, the particular arrangements of system elements shown herein are by way 5 of example, and other embodiments could implement the invention using other types of devices, including desktop, laptop or palmtop computers, personal digital assistant (PDAs), televisions, set-top boxes, as well as portions or combinations of these and other devices.

10 It should also be noted that a removable card and its corresponding host in accordance with the invention can be implemented in any number of different arrangements. For example, the card itself need not have any particular size, shape or physical configuration. In addition, the invention may be 15 implemented using other types and arrangements of CPUs, microprocessors, application specific integrated circuits (ASICs), as well as combinations or portions of these and other processors, in conjunction with many different types of memories, e.g., an electronic memory, an optical or magnetic disk-based memory or 20 other storage device. Moreover, the invention can be implemented at least in part in the form of one or more software programs stored in a memory and executed by a processor. These and numerous other embodiments within the scope of the following claims will be apparent to those skilled in the art.